

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

PCT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference B2003009 WO	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/IB2004/002334	International filing date (day/month/year) 20.07.2004	Priority date (day/month/year) 21.07.2003
International Patent Classification (IPC) or national classification and IPC F16J 15/08, F16L 27/04, 37/28, F16K 1/32, 1/46		
Applicant Vetco Aibel AS et al		

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 6 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:

- ☒ (sent to the applicant and to the International Bureau) a total of 9 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
- ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

- This report contains indications relating to the following items:

- ☒ Box No. I Basis of the report
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand 20.05.2005	Date of completion of this report 31.10.2005
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Form PCT/IPEA/409 (cover sheet) (April 2005)

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/IB2004/002334

Box No. I Basis of the report

1. With regard to the language, this report is based on:

- ☒ the international application in the language in which it was filed
☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of:
☐ international search (Rules 12.3(a) and 23.1(b))
☐ publication of the international application (Rule 12.4(a))
☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

- ☐ the international application as originally filed/furnished
☒ the description:
 pages 1 - 22 as originally filed/furnished
 pages* _____ received by this Authority on _____
 pages* _____ received by this Authority on _____
☒ the claims:
 pages _____ as originally filed/furnished
 pages* _____ as amended (together with any statement) under Article 19
 pages* 23 - 31 received by this Authority on 22.08.2005
 pages* _____ received by this Authority on _____
☒ the drawings:
 pages 1 - 8 as originally filed/furnished
 pages* _____ received by this Authority on _____
 pages* _____ received by this Authority on _____
☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing (*specify*): _____
☐ any table(s) related to the sequence listing (*specify*): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
☐ the claims, Nos. _____
☐ the drawings, sheets/figs _____
☐ the sequence listing (*specify*): _____
☐ any table(s) related to the sequence listing (*specify*): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/IB2004/002334

Box No. IV Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has, within the applicable time limit:

- ☒ restricted the claims
- ☐ paid additional fees
- ☐ paid additional fees under protest and, where applicable, the protest fee
- ☐ paid additional fees under protest but the applicable protest fee was not paid
- ☐ neither restricted the claims nor paid additional fees

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is:

- ☒ complied with
- ☐ not complied with for the following reasons:

4. Consequently, this report has been established in respect of the following parts of the international application:

- ☒ all parts
- ☐ the parts relating to claims Nos. _____

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/IB2004/002334

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-27</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-27</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-27</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

Documents cited in the International Search Report:

D1: GB 2013810 A
D2: EP 0040268 A1
D3: US 4087323 A
D4: WO 9307414 A1
D5: US 5379798 A
D6: US 5950985 A
D7: US 3420497 A
D8: US 5320133 A
D9: US 4132386 A

Claims 1-17:

Document D1, which is considered to represent the most relevant state of the art, discloses (see abstract and fig. 1-3) a coupling device from which the subject-matter of claim 1 differs in that the invention is directed towards a hydraulic subsea coupling, where the spherical contact surfaces of the male sealing member are designed to mate and form a fluid tight seal with a corresponding internal conical contact surface of the female sealing member.

The problem to be solved by the present invention may therefore be regarded as that of finding an alternative application for the coupling as well as providing a coupling device making possible a simple interconnection of two female coupling parts with relatively low requirement with respect to tolerances and mutual alignment, while offering a reliable sealing between the two female coupling parts.

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: BOX V

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

The coupling device revealed in D1 is described with reference to a manifold coupling and it is understood that the invention is not limited to such couplings. However, D1 does not indicate any alternative applications that would lead a person skilled in the art to use it as a hydraulic subsea coupling. Also, the spherical contact surface of the male sealing member is designed for mating with an internal cylindrical contact surface (16, 22) and not with an internal conical surface.

Although, both D2 (see fig. 1-2) and D3 (see fig. 2) disclose similar coupling devices with spherical male sealing members designed for mating with corresponding female internal conical sealing members. None, of the documents discloses a hydraulic subsea coupling provided with an intermediate member which forms a continuous part together with the male sealing members and which is mechanically compressible so as to be capable to store elastic energy when the body is subjected to axial compression.

D4 discloses (see fig. 1) a coupling device with spherical male sealing members designed for mating with corresponding female internal spherical sealing members. Hence, it does not reveal a hydraulic subsea coupling provided with a male spherical surface designed for mating with a female internal conical surface, and an intermediate member which forms a continuous part together with the male sealing members and which is mechanically compressible so as to be capable to store elastic energy when the body is subjected to axial compression.

Furthermore, D5 discloses (see fig. 1-3) a coupling used as a hydraulic subsea coupling, but the spherical contact surface of the male sealing member is designed for mating with an internal cylindrical contact surface (like the coupling disclosed in D1) and not with an internal conical surface. This coupling also lacks an intermediate member which forms a continuous part together with the male sealing members and

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: BOX V

which is mechanically compressible so as to be capable to store elastic energy when the body is subjected to axial compression.

D6-D8 discloses different quick couplings provided with valves to prevent fluid from flowing out when it is disconnected. All of these couplings lack two opposite male sealing members, designed for mating with internal conical contact surfaces and an intermediate member which forms a continuous part together with the male sealing members and which is mechanically compressible so as to be capable to store elastic energy when the body is subjected to axial compression. Furthermore, none of the couplings revealed in D6-D8 are hydraulic subsea couplings.

Consequently, taking claim 1 as a whole, none of documents D1-D8 give any indication that would lead a person skilled in the art towards a hydraulic coupling device according to claim 1. Therefore, the invention according to claim 1 meet the requirements of the PCT with respect to novelty and inventive step.

Claims 2-17 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Claims 18-27:

The cited documents D1-D9 (of which D9 is considered most relevant) represent the general state of the art. The invention defined in claims 18-27 is not disclosed by these documents.

The cited prior art does not give any indication that would lead a person skilled in the art to the claimed valve device. Therefore, the claimed invention is not obvious to a person skilled in the art.

Accordingly, the invention defined in claims 18-27 is novel and is considered to involve an inventive step.

The invention is industrially applicable.

CLAIMS

1. A hydraulic subsea coupling device comprising:

- a male coupling part (20) in the form of a sealing element comprising a hollow body (26) of metallic material with a first male sealing member (21a) formed at a first end of the body (26) and a second male sealing member (21b) formed at a second end of the body (26) opposite said first end;

- a first female coupling part (10) provided with a first female sealing member (11) and having an internal bore (12) extending through the coupling part (10) and its female sealing member (11); and

- a second female coupling part (30) provided with a second female sealing member (31),

characterized in:

- that the first male sealing member (21a) has an external spherical contact surface (23a) designed for mating with a corresponding internal conical contact surface (13) of the first female sealing member (11) so as to form a fluid-tight seal between the first male sealing member and the first female sealing member when their contact surfaces are pressed against each other;

- that the second male sealing member (21b) has an external spherical contact surface (23b) designed for mating with a corresponding internal conical contact surface (33) of the second female sealing member (31) so as to form a fluid-tight seal between the second male sealing member and the second female sealing member when their contact surfaces are pressed against each other;

- that the body (26) is provided with an intermediate member (24), which forms a continuous part together with the first and second male sealing members (21a, 21b) and which is mechanically compressible so as to be capable to store elastic energy when the body (26) is subjected to axial compression; and

- that an internal bore (22) extends through the body (26) and through the first and second male sealing members (21a, 21b) and the intermediate member (24), the spherical contact surface (23a,

23b) of the respective male sealing member (21a, 21b) surrounding said internal bore (22).

- 5 2. A hydraulic subsea coupling device according to claim 1, **characterized** in that the first male sealing member (21a) is coaxial with the second male sealing member (21b).
- 10 3. A hydraulic subsea coupling device according to claim 1 or 2, **characterized** in that the intermediate member (24) is expandable by an internal fluid pressure in the body (26) so as to urge the respective male sealing member (21a, 21b) outwards in the axial direction of the body (26) against the corresponding female sealing member when the sealing element is fitted between said female sealing members, thereby increasing the sealing contact pressure between the respective male sealing member and the corresponding female sealing member.
- 15 4. A hydraulic subsea coupling device according to claim 3, **characterized** in that the intermediate member (24) has an internal cross-sectional area which is larger than the external cross-sectional area of the respective male sealing member (21a, 21b) as seen at the point (P) of the male sealing member where the male sealing member is designed to engage with the corresponding female sealing member.
- 20 5. A hydraulic subsea coupling device according to any one of claims 1-4, **characterized** in that the intermediate member (24) is essentially shaped as a single or multiple wave bellows.
- 25 6. A hydraulic subsea coupling device according to any one of claims 1-5, **characterized** in that the second female coupling part (30) has an internal bore (32) extending through the coupling part (30) and its female sealing member (31).
- 30 7. A hydraulic subsea coupling device according to any one of claims 1-5, **characterized** in that the second female coupling part (30) is designed as a stop member adapted to close the internal bore (22)
- 35

of the male coupling part (20) when the male coupling part is clamped between the first and second female coupling parts (10, 30).

- 5 8. A hydraulic subsea coupling device according to any one of claims 1-7, **characterized** in:
- that at least one of the first and second female coupling parts (10, 30) is provided with a valve (40), which comprises a valve body (41) displaceably arranged inside the internal bore (12, 32) of the female coupling part and a spring member (42) acting on the valve body, the valve body being displaceable against the action of the spring member (42) from a first position, in which the valve is closed and prevents fluid flow through the internal bore (12, 32) of the female coupling part, to a second position, in which the valve is open and allows fluid flow through the internal bore of the female coupling part; and
 - that the male coupling part (20) is provided with an actuation member (25) for displacing the valve body (41) from said first position to said second position immediately before the female sealing member (11, 31) of the female coupling part (10, 30) is brought into engagement with the corresponding male sealing member (21a, 21b) of the male coupling part (20).
- 25 9. A hydraulic subsea coupling device according to claim 8, **characterized** in:
- that the valve (40) comprises a housing (43) which is immovably fixed inside the internal bore (12, 32) of the female coupling part (10, 30), said housing being provided with a cavity (44) accommodating the spring member (42) and a part of the valve body (41);
 - and
 - that said cavity (44) is in fluid communication with an orifice (45) at the end of the valve facing the free end of the female sealing member (11, 31) of the female coupling part (10, 30) so as to allow the cavity to be in fluid communication with the surroundings via said orifice (45) when the female coupling part (10, 30) is out of engagement with the male coupling part (20).

- 5 10. A hydraulic subsea coupling device according to claim 9, **characterized** in that the actuation member (25) is adapted to restrict the flow through the orifice (45) when the female sealing member (11, 31) is in engagement with the corresponding male sealing member (21a, 21b).
- 10 11 A hydraulic subsea coupling device according to claim 9 or 10, **characterized** in that the cavity (44) is in fluid communication with the orifice (45) via a channel (46) extending through the valve body (41).
- 15 12. A hydraulic subsea coupling device according to claim 11, **characterized** in that said channel (46) extends axially through the valve body (41).
- 20 13. A hydraulic subsea coupling device according to claim 11 or 12, **characterized** in that the actuation member (25) is adapted to engage with the valve body (41) so as to cover the orifice (45) and thereby restrict the flow through the orifice when the female sealing member (11, 31) is in engagement with the corresponding male sealing member (21a, 21b).
- 25 14. A hydraulic subsea coupling device according to any one of claims 8-13, **characterized** in:
- 30 - that the valve (40) is provided with a ring-shaped seal element (47) arranged in an annular groove (48), which groove is provided in the inner wall (49) of the internal bore (12, 32) of the female coupling part; and
- that an external surface (50) of the valve body is adapted to engage with the ring-shaped seal element (47) so as to form a fluid-tight seal between the inner wall (49) of the internal bore (12, 32) and the valve body (41) when the valve body is in said first position.
- 35 15. A hydraulic subsea coupling device according to any one of claims 8-14, **characterized** in:

- that the valve body (41) comprises a first body part (41a) and a second body part (41b), said first body part (41a) being located in front of the second body part (41b) as seen in a direction along the associated internal bore (12, 32) towards the associated female sealing member (11, 31);

- that a first flow path section (51a) is provided radially outwardly of the first body part (41a) between the valve housing (43) and the inner wall (49) of the internal bore (12, 32), and a second flow path section (51b) is provided between the second body part (41b) and said inner wall (49), said first and second flow path sections (51a, 51b) extending essentially in the axial direction of the internal bore (12, 32) on mutually different levels as seen in the radial direction of the internal bore;

- that the first flow path section (51a) is connected to the second flow path section (51b) via an intermediate flow path section (51c) extending obliquely in relation to the first and second flow path sections (51a, 51b); and

- that the first body part (41a) is adapted to block the intermediate flow path section (51c) when the valve body (41) is displaced from said second position to said first position.

16. A hydraulic subsea coupling device according to claim 15 in combination with claim 14, **characterized** in that the second body part (41b) has a smaller cross-sectional area than the first body part (41a), that the second body part (41b) is surrounded by the ring-shaped seal element (47) and out of engagement therewith when the valve body is in said second position, that an external surface of the first body part (41a) is adapted to be brought into engagement with the ring-shaped seal element (47) so as to form a fluid-tight seal between the inner wall (49) of the internal bore (12, 32) and the valve body (41) when the valve body is displaced from said second position to said first position, and that the end of the first body part (41a) facing the second body part (41b) only has blunt edges so that the ring-shaped seal element (47) will meet no sharp edge when the valve body (41) is displaced between said positions.

17. A hydraulic subsea coupling device according to claim 15 or 16,
characterized in that the intermediate flow path section (51c) is
defined partly by an external surface (50c) of the valve body (41)
which extends obliquely, as seen in the axial direction of the valve
body (41), between the first body part (41a) and the second body
part (41b).

18. A valve device, **characterized** in:

- that it comprises a first valve part (110) provided with a first female sealing member (111) and having an internal bore (112) extending through the valve part (110) and its female sealing member (111), a second valve part (130) provided with a second female sealing member (131), and a sealing element (20) interposed between the first female sealing member (111) and the second female sealing member (131);
- that the sealing element comprises a hollow body (26) of metallic material with a first male sealing member (21a) formed at a first end of the body (26) and a second male sealing member (21b) formed at a second end of the body (26) opposite said first end, the respective male sealing member (21a, 21b) having an external spherical contact surface (23a, 23b);
- that an internal bore (22) extends through the body (26) and through the first and second male sealing members (21a, 21b), the spherical contact surface (23a, 23b) of the respective male sealing member (21a, 21b) surrounding said internal bore (22);
- that the first female sealing member (111) has an internal conical contact surface (113) of metallic material for engagement with the spherical contact surface (23a) of the first male sealing member (21a), the spherical contact surface (23a) of the first male sealing member and the corresponding conical contact surface (113) of the first female sealing member being designed to form a fluid-tight seal between the sealing element (20) and the first valve part (110) when said contact surfaces (23a, 113) are pressed against each other; and
- that the second female sealing member (131) is provided with an internal conical contact surface (133) of metallic material for engagement with the spherical contact surface (23b) of the second

5 male sealing member (21b), the spherical contact surface (23b) of the second male sealing member and the corresponding conical contact surface (133) of the second female sealing member being designed to form a fluid-tight seal between the sealing element (20) and the second valve part (130) when said contact surfaces (23b, 133) are pressed against each other.

10 19. A valve device according to claim 18, characterized in that the first valve part (110) and the second valve part (130) are displaceable in relation to each other in the axial direction of the body (26) of the sealing element (20) between a first position, in which the contact surface (23a, 23b) of both male sealing members (21a, 21b) is pressed against its corresponding contact surface (113, 133) of the female sealing members (111, 131), and a second position, in which the contact surface (23a, 23b) of at least one of the male sealing members (21a, 21b) is out of engagement with its corresponding contact surface (113, 133) of the female sealing members (111, 131).

20 20. A valve device according to claim 19, characterized in that the contact surface (23b) of the second male sealing member (21b) is out of engagement with the corresponding contact surface (133) of the second female sealing member (131), whereas the contact surface (23a) of the first male sealing member (21a) is in engagement with the corresponding contact surface (113) of the first female sealing member (111), when the first and second valve parts (110, 130) are in said second position.

30 21. A valve device according to claim 19 or 20, characterized in that the valve device (102) is provided with a flow channel (103), which is connected to the internal bore (112) of the first valve part (110) via the space between the first female sealing member (111) and the second female sealing member (131), and that said flow channel (103) is in fluid communication with the internal bore (112) of the first valve part when the first and second valve parts (110, 130) are in said first position, whereas said flow channel (103) is not in fluid communication with the internal bore (112) of the first

valve part when the first and second valve parts (110, 130) are in said second position.

22. A valve device according to any one of claims 18-21, characterized in that the valve device (102) constitutes a subsea valve.

23. A valve device according to any one of claims 18-22, characterized in that the first male sealing member (21a) is coaxial with the second male sealing member (21b).

24. A valve device according to any one of claims 18-23, characterized in that the body (26) is provided with an intermediate member (24), which forms a continuous part together with the first and second male sealing members (21a, 21b) and which is mechanically compressible so as to be capable to store elastic energy when the body (26) is subjected to axial compression, and that the internal bore (22) extends through said intermediate member (24).

25. A valve device according to claim 24, characterized in that the intermediate member (24) is expandable by an internal fluid pressure in the body (26) so as to urge the respective male sealing member (21a, 21b) outwards in the axial direction of the body (26) against the corresponding female sealing member when the sealing element is fitted between said female sealing members, thereby increasing the sealing contact pressure between the respective male sealing member and the corresponding female sealing member.

26. A valve device according to claim 25, characterized in that the intermediate member (24) has an internal cross-sectional area which is larger than the external cross-sectional area of the respective male sealing member (21a, 21b) as seen at the point (P) of the male sealing member where the male sealing member is designed to engage with the corresponding female sealing member.

27. A valve device according to any one of claims 24-26, characterized in that the intermediate member (24) is essentially shaped as a single or multiple wave bellows.

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